

In re Patent Application of:

ZENG

Serial No. **09/844,347**

Filing Date: **April 27, 2001**

REMARKS

Applicant would like to thank the Examiner for the thorough examination of the present application. Independent Claims 23, 32 and 36 have been amended to address the informalities as helpfully noted by the Examiner.

The Examiner also rejected Claims 23, 26, 32 and 36 as being indefinite based upon the Examiner not understanding how the dielectric layer extends outwardly from the semiconductor layer, the source regions and the source/body contact regions. In addition, the Examiner does not understand how the sidewalls of the outwardly extending dielectric layer are aligned with sidewalls of the trench.

Reference is initially directed to FIG. 4 and to page 7, line 15 through page 8, line 20 in the Applicant's specification in which a method for making the MOSFET in accordance with the present invention is discussed. In addition, the particular process steps for forming the dielectric layer so that it extends outwardly from the semiconductor layer, the source regions and the source/body contact regions are illustrated in greater detail in FIGS. 5-13. In particular, reference is directed to the discussion supporting FIG. 9. Discussion of each process step as illustrated in FIGS. 5-13 may be found between page 8, line 21 and page 13, line 11 in the Applicant's specification. The Applicant thus submits that Claims 23, 26, 32 and 36 are definite.

Independent Claim 23 has been amended to include the subject matter from dependent Claim 30 to more clearly define the present invention over the cited prior art references. Dependent Claim 30 has now been cancelled. Independent Claim

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32 has also been amended to more clearly define the present invention over the cited prior art references. The claim amendments and arguments supporting patentability of the claims are presented in detail below.

I. Independent Claim 23 Is Patentable

The Examiner rejected independent Claim 23 over the published patent application to Williams et al. Since independent Claim 23 has been amended to include the subject matter from dependent Claim 30, the rejection of Claim 23 will include discussion of the Han et al. patent cited with respect to Claim 30.

Amended independent Claim 23 is directed to a MOSFET comprising a semiconductor layer having a trench therein, a gate dielectric layer lining the trench, and a gate conducting layer in a lower portion of the trench. A dielectric layer is in an upper portion of the trench. The MOSFET further includes source regions adjacent the dielectric layer.

Independent Claim 23 has been amended to recite the subject matter from dependent Claim 30. In particular, the source/body contact regions are laterally spaced apart from the trench, and are also recessed within the semiconductor layer and non-interruptively contact the source regions. The dielectric layer extends outwardly from the semiconductor layer, the source regions, and the source/body contact regions and has sidewalls aligned with sidewalls of the trench.

The MOSFET is advantageously formed with the upper portion of the dielectric layer in the trench extending outwardly from the semiconductor layer, the source regions, and the source/body contact regions wherein sidewalls of the

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outwardly extending dielectric layer are aligned with sidewalls of the trench. This feature of the present invention advantageously allows spacers to be formed laterally adjacent the outwardly extending dielectric layer, which are then used as self-aligned masks for implanting dopants into the semiconductor layer.

In addition, the on-resistance is reduced since each MOSFET includes a source/body contact region that is laterally spaced apart from the trench and non-interruptively contacts the source regions. The source/body contact regions thus provide an efficient short between the source and body regions of the MOSFET. As a result, device ruggedness is increased.

Referring now more particularly to the Williams et al. patent application, FIG. 15D illustrates a MOSFET comprising a semiconductor layer having a trench therein, a gate conducting layer in a lower portion of the trench, and a dielectric layer in an upper portion of the trench. Source regions 159 are adjacent the dielectric layer. Source/body contact regions 160 are laterally spaced apart from the gate conducting layer and non-interruptively contact the source regions 159. The dielectric layer extends outwardly from the semiconductor layer, the source regions 159 and the source/body contact regions 160, and the outwardly extending dielectric layer has sidewalls aligned with sidewalls of the trench.

As correctly noted by the Examiner when discussing the rejection of dependent Claim 30, Williams et al. fails to disclose that the source/body contact regions are recessed within the semiconductor layer adjacent the source regions. The Examiner cited the Han et al. patent as disclosing this

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feature of the claimed invention.

As best illustrated in FIG. 3A of Han et al., a source/body contact region 17 is recessed within a semiconductor layer 3 adjacent the source regions 19. The Examiner has taken the position that it would have been obvious at the time of the invention to modify the source/body contact regions 160 in Williams et al. so that they are recessed within the semiconductor layer as disclosed in Han et al.

The Applicant respectfully submits that even if the references were combined as suggested by the Examiner, the claimed invention is still not produced. For example, independent Claim 23 has also been amended to recite that the source/body contact regions are laterally spaced apart from the trench, as well as being recessed within the semiconductor layer. In sharp contrast, the source/body contact region 17 in FIG. 3A of Han et al. is contacting the lower portion of the trench. Accordingly, it is submitted that amended independent Claim 23 is patentable over the Williams et al. patent application in view of the Han et al. patent.

II. Independent Claim 32 Is Patentable

The Examiner rejected independent Claim 32 over the Williams et al. patent application in view of the Pitzer et al. patent. Amended independent Claim 32 is directed to a MOSFET comprising a semiconductor layer having a trench therein, a gate dielectric layer lining the trench, and a gate conducting layer in a lower portion of the trench. A dielectric layer is in an upper portion of the trench.

The MOSFET further includes source regions adjacent

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the dielectric layer, and source/body contact regions laterally spaced apart from the gate conducting layer and non-interruptively contacting the source regions. The dielectric layer extends outwardly from the semiconductor layer, the source regions, and the source/body contact regions and has sidewalls aligned with sidewalls of the trench. A source electrode is on the source regions and on the dielectric layer, and at least one conductive via is between the source electrode and the source/body contact regions. Independent Claim 32 has been amended to recite that the conductive via also extends through the source regions.

The MOSFET is advantageously formed with a conductive via extending through the source regions between the source electrode and the source/body contact regions. The on-resistance is reduced since each MOSFET includes a source/body contact region that is contacting the source region as well as the source electrode. The source/body contact regions thus provide an efficient short between the source and body regions of the MOSFET. As a result, device ruggedness is increased.

The Williams et al. patent application has been discussed in detail above. As correctly noted by the Examiner, Williams et al. fails to disclose at least one conductive via between the source electrode and the source/body contact regions. The Examiner cited the Pitzer et al. patent as disclosing this feature of the claimed invention.

Referring now to the Pitzer et al. patent, the Examiner has taken the position that FIG. 2 discloses a conductive via between the source electrode 52 and the

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source/body contact region 34. The Examiner does not specifically identify the conductive via in FIG. 2 of the Pitzer et al. patent, but it is assumed to be the field plate 66.

The Applicant respectfully submits that even if the references were combined as suggested by the Examiner, the claimed invention is still not produced. For example, independent Claim 32 has been amended to recite that the at least one conductive via extends through the source regions between the source electrode and the source/body contact regions. As illustrated in FIG. 2 of Pitzer et al., the field plate 66 is above the source region 30 and the source/body contact region 34. Consequently, the field plate 66 does not extend through the source region 30, as in the claimed invention. Accordingly, it is submitted that amended independent Claim 32 is patentable over the Williams et al. patent application in view of the Pitzer et al. patent.

III. Independent Claim 36 Is Patentable

The Examiner rejected independent Claim 36 over the Williams et al. patent application in view of the Marchant et al. patent application. Independent Claim 36 is directed to a MOSFET comprising a semiconductor layer having a trench therein, a gate dielectric layer lining the trench, and a gate conducting layer in a lower portion of the trench. A dielectric layer is in an upper portion of the trench and extends outwardly from the semiconductor layer. The outwardly extending dielectric layer has sidewalls aligned with sidewalls of the trench.

The MOSFET further comprises source regions adjacent

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the dielectric layer and includes an opening therein. Source/body contact regions are laterally spaced from the gate conducting layer and non-interruptively contact the source regions. The source/body contact regions are exposed by the opening in the source regions. The dielectric layer extends outwardly from the semiconductor layer, the source regions and the source/body contact regions, and the outwardly extending dielectric layer has sidewalls aligned with sidewalls of the trench.

The MOSFET is advantageously formed with the source/body contact regions exposed by the opening in the source regions. The on-resistance is reduced since each MOSFET includes a source/body contact region that is contacting the source region as well as the source electrode. The source/body contact regions thus provide an efficient short between the source and body regions of the MOSFET. As a result, device ruggedness is increased.

The Williams et al. patent application has been discussed in detail above. As correctly noted by the Examiner, Williams et al. fails to disclose in FIG. 15D a portion of the source regions 159 including an opening to expose the source/body contact regions 160. The Examiner cited the Marchant et al. patent application as disclosing this feature of the claimed invention.

In particular, the Examiner references FIGS. 2 and 4 in Marchant et al. as disclosing source regions 402 adjacent the dielectric layer and including an opening therein, and source/body contact regions 404 being exposed by the opening in the source regions. The Examiner has taken the position

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that it would have been obvious to modify the trenched MOSFET of Williams et al. to include opening through the source regions 159 as disclosed by Marchant et al.

The Applicant respectfully submits that there is no proper motivation to modify the prior art references as suggested by the Examiner. First, the source/body contact region 160 and the source region 159 in Williams et al. are laterally adjacent one another. Since they are laterally adjacent one another, there is no reason to form a recess or opening in the source region 159 to expose the source/body contact region 160 - especially when the source/body contact region 160 is laterally adjacent the source region 159 and is already contacting the source electrode 158.

In the claimed invention, an advantage of exposing the source/body contact regions is that the source electrode will also contact the source/body contact region as well as the source regions, as recited in dependent Claim 37, for example. This arrangement is already present in the Williams et al. patent application. Accordingly, it is submitted that independent Claim 36 is patentable over the Williams et al. patent application in view of the Marchant et al. patent application.


In view of the patentability of independent Claims 23, 32 and 36, it is submitted that their dependent claims which recite yet further distinguishing features of the invention are also patentable. These dependent claims need no further discussion herein.

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CONCLUSION

In view of the amendments to the claims and the arguments provided herein, it is submitted that all the claims are patentable. Accordingly, a Notice of Allowance is requested in due course. Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Respectfully submitted,


MICHAEL W. TAYLOR
Reg. No. 43,182
Allen, Dyer, Doppelt, Milbrath
& Gilchrist, P.A.
255 S. Orange Avenue, Suite 1401
Post Office Box 3791
Orlando, Florida 32802
407-841-2330

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CERTIFICATE OF FACSIMILE TRANSMISSION

I HEREBY CERTIFY that the foregoing
correspondence has been forwarded via facsimile number 703-
872-9306 to the Commissioner for Patents on this 19 day of
July, 2004.

Knut Zank